

Efficacy and safety of 10F percutaneous catheter versus 28F chest tube in pneumothorax: A retrospective comparative study

10F catheter vs. 28F tube in pneumothorax

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Abstract

Aim: Percutaneous catheter drainage has emerged as a less invasive alternative to traditional large-bore chest tubes in the management of pneumothorax. This study aimed to compare the clinical outcomes of 10F percutaneous catheters with 28F chest tubes.

Materials and Methods: A retrospective analysis was conducted on 78 patients treated for pneumothorax between May 2023 and May 2025. Patients were divided into two groups: those treated with a 10F percutaneous catheter (n=40) and those treated with a 28F chest tube (n=38). Demographics, pneumothorax etiology, length of hospital stay, drainage duration, prolonged air leak, and need for video-assisted thoracoscopic surgery (VATS) were evaluated. Statistical analyses included Mann-Whitney U, Fisher's exact, and Chi-square tests with Monte Carlo simulation where appropriate.

Results: There were no significant differences between groups in age (p=0.1596), sex (p=0.1406), pneumothorax side (p=0.4383), or COPD prevalence (p=0.9382). Etiological distribution showed a statistically significant difference (p=0.0051); notably, 10F catheters were not utilized in cases of penetrating trauma. Mean hospital stay and drainage duration were not significantly different between groups (p=0.0656 and p=0.2709, respectively). The rates of prolonged air leak (p=0.3493) and VATS requirement (p=0.9495) were also similar.

Discussion: The 10F percutaneous catheter demonstrated comparable efficacy and safety to the conventional 28F chest tube in the management of pneumothorax. Despite being less invasive, it yielded similar clinical outcomes, supporting its use as a safe and effective alternative for treating spontaneous pneumothorax and blunt trauma cases.

Keywords

pneumothorax, catheterization, chest tubes, drainage, air leak

Introduction

Pneumothorax, defined as the presence of air in the pleural space, can compromise respiratory function and lead to potentially life-threatening consequences if not managed promptly and effectively [1]. It may occur spontaneously (primary or secondary), traumatically, or iatrogenically, and its clinical presentation varies from asymptomatic to severe respiratory distress depending on the underlying etiology and patient comorbidities [2,3]. The primary goal of treatment is to evacuate intrapleural air, allow lung re-expansion, and prevent recurrence [4].

Traditionally, large-bore chest tubes (e.g., 28F–32F (French)) inserted via thoracostomy have been the standard of care for moderate to large pneumothoraces, especially in traumatic or secondary cases [5]. However, these tubes are associated with significant patient discomfort, longer hospital stays, and complications such as infection, bleeding, and injury to surrounding structures [6]. In recent years, minimally invasive techniques using small-bore catheters, typically inserted percutaneously under imaging guidance, have gained popularity due to their reduced procedural trauma and improved patient comfort [7–9].

Several studies have demonstrated that small-bore catheters (≤ 14 F), including pigtail catheters and percutaneous drainage tubes, can achieve similar clinical outcomes to large-bore chest tubes in the treatment of spontaneous or iatrogenic pneumothorax [10–12]. In particular, 10F percutaneous catheters have been increasingly adopted as an initial management strategy, especially in cases not related to major trauma [13,14]. The American College of Chest Physicians and British Thoracic Society both acknowledge small-bore catheters as appropriate for stable patients with spontaneous pneumothorax, although evidence remains heterogeneous [1, 14].

Despite growing interest in percutaneous catheters, there remains some reluctance among clinicians to favor them over conventional chest tubes, especially in more complex or traumatic cases [15]. Concerns persist regarding prolonged air leaks, higher failure rates, and the potential need for escalation to surgical intervention such as video-assisted thoracoscopic surgery (VATS) [16]. Furthermore, comparative data on the efficacy and safety of small-bore percutaneous catheters versus standard large-bore chest tubes in mixed patient populations—including trauma cases—remain limited, particularly in real-world clinical settings.

This study aims to address this knowledge gap by retrospectively comparing the clinical outcomes of 10F percutaneous catheters and 28F chest tubes in patients treated for pneumothorax over a two-year period at a tertiary care center. By analyzing parameters such as drainage duration, length of hospital stay, complication rates, and need for surgical intervention, we aim to evaluate whether the less invasive 10F catheter represents a safe and effective alternative to traditional chest tubes across a diverse pneumothorax population.

Materials and Methods

Study Design and Setting

This retrospective comparative study was conducted at a

tertiary care university hospital between May 2023 and May 2025. The study protocol was approved by the institutional ethics committee (Approval No: 2024-KAEK-24) and conducted in accordance with the Declaration of Helsinki. Informed consent was waived by the ethics committee due to the retrospective nature of the study.

Study Population

Patients aged ≥ 18 years who were diagnosed with pneumothorax and underwent interventional drainage were included. Both isolated pneumothorax and hemopneumothorax cases were eligible for inclusion. Patients were divided into two groups based on the initial intervention: the 10F percutaneous catheter group and the 28F chest tube group. The choice of drainage method was at the discretion of the attending physician, based on clinical status and radiological findings.

Patients with tension pneumothorax, hemopneumothorax, and various etiologies—including spontaneous, traumatic (blunt and penetrating), and iatrogenic pneumothorax—were eligible for inclusion. Clinical decision-making was based on patient stability and radiological findings. Clinically unstable patients were treated with immediate chest tube thoracostomy. In stable patients, 10F percutaneous catheters were preferred when imaging showed >2 cm separation from the lateral chest wall to allow safe percutaneous access. If catheter placement failed or was technically not feasible, conversion to chest tube drainage was performed. In cases with <2 cm separation, chest tube placement was preferred. Additionally, in all cases of penetrating trauma, large-bore chest tubes were used in accordance with standard trauma care protocols.

Exclusion Criteria

Patients were excluded if they [1] had incomplete medical records, [2] were non-compliant with treatment (e.g., self-discharge or refusal of procedure), or [3] experienced a failed catheter or tube insertion requiring immediate conversion.

Operator and Standardization

All procedures, including both catheter and chest tube placements, as well as any surgical interventions, were performed by a single experienced thoracic surgeon, ensuring consistency in technique and clinical decision-making throughout the study period.

Diagnostic and Procedural Approach

All diagnoses were confirmed via thoracic computed tomography (CT). In patients considered for catheter placement, a wireless Clarius ultrasound device (Clarius Mobile Health Corp., Vancouver, Canada) was used to confirm the presence and extent of pneumothorax and to assess thoracic anatomy in order to determine suitability for catheter thoracostomy (Figure 1).

In the 10F catheter group, procedures were performed under real-time ultrasonography (USG) guidance at the 4th or 5th intercostal space along the mid-axillary line, within the “safe triangle”. Chest tubes (28F) were placed via standard blunt dissection using the same anatomical landmarks. All procedures were carried out under sterile conditions. A post-procedural chest radiograph was obtained to confirm the correct positioning of the catheter and to assess lung re-expansion (Figure 2).

Surgical Intervention

Patients who did not respond to drainage or developed

complications were evaluated for video-assisted thoracoscopic surgery (VATS). Surgical indications were based on standard clinical criteria including persistent air leak, incomplete lung expansion, or recurrence, at the discretion of the surgeon.

Data Collection

Demographic and clinical variables recorded included age, sex, comorbidities (especially chronic obstructive pulmonary disease (COPD)), etiology (spontaneous, traumatic, iatrogenic), side of pneumothorax, length of hospital stay, drainage duration, presence of prolonged air leak (defined as air leak >7 days), and need for VATS. Data were collected from electronic medical records by two independent researchers and verified for consistency.

Sample Size Calculation

Using G*Power (version 3.1; Heinrich Heine University, Düsseldorf, Germany), a sample size of 72 patients (36 per group) was calculated to detect a moderate effect size ($d = 0.6$) in hospital stay with $\alpha = 0.05$ and power = 0.80. The final study population consisted of 78 patients (40 in the 10F group and 38 in the 28F group), satisfying the power requirement.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). The Shapiro–Wilk test was used to assess normality of continuous variables. Non-normally distributed continuous data were compared using the Mann–Whitney U test. Categorical variables were analyzed using the Chi-square test or Fisher’s exact test, with Monte Carlo simulation applied where appropriate. A two-tailed p-value <0.05 was considered statistically significant.

Ethical Approval

This study was approved by the Ethics Committee of Kastamonu University Clinical Ethics Committee (Date: 2024-07-02, No: 2024-KAEK-24).

Results

A total of 91 patients were assessed for eligibility during the study period. Thirteen patients were excluded for the following reasons: five patients died due to non-pneumothorax-related causes before treatment could be completed, three were referred to external centers during follow-up, two patients were initially managed with percutaneous catheter insertion but were switched to chest tube drainage due to massive air leak

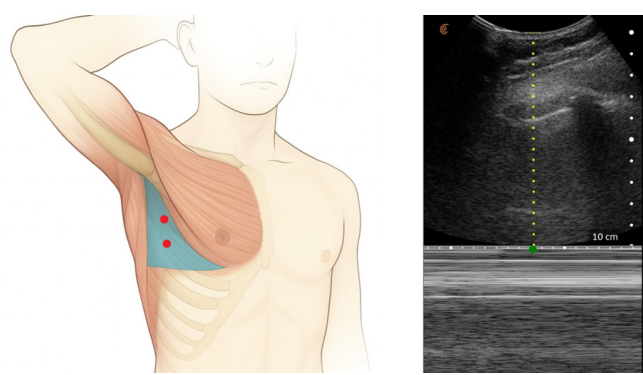


Figure 1. Anatomical landmark and thoracic ultrasound imaging demonstrating the ‘barcode sign’ indicative of pneumothorax with corresponding appropriate intervention site

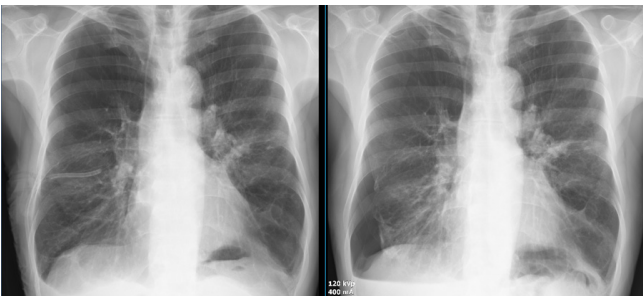


Figure 2. Right-sided pneumothorax: pre- and post-catheter insertion chest radiographs

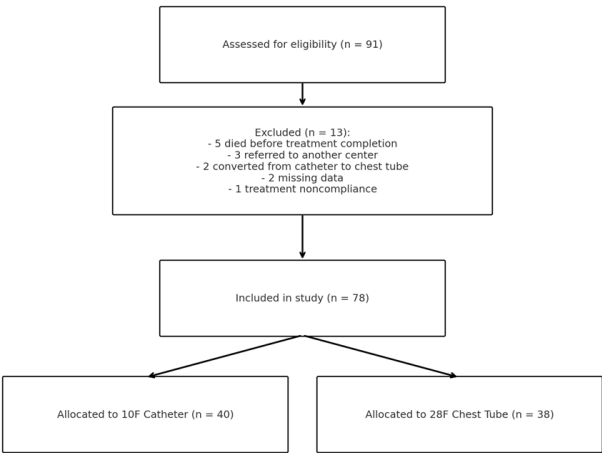


Figure 3. Consort diagram

Table 1. Baseline demographic and clinical characteristics of patients treated with 10F percutaneous catheter and 28F chest tube

Variable	10F (n = 40)	28F (n = 38)	p-value
Age	43.9 ± 22.7	36 ± 17.4	0.1596
Male	30	34	0.1406
Right Sided Disease	24	26	0.4383
COPD	4	4	0.9382
Etiology			
PSP	26	18	0.0051
SSP	5	6	
Blunt Trauma	9	6	
Penetrating Trauma	0	8	

COPD, chronic obstructive pulmonary disease; PSP, primary spontaneous pneumothorax; SSP, secondary spontaneous pneumothorax.

Table 2. Comparison of clinical outcomes between 10F catheter and 28F chest tube groups

Variable	10F (n = 40)	28F (n = 38)	p-value
Length of Hospital Stay (days)	7.4 ± 6.7	4.6 ± 2.3	0.0656
Drainage Time (days)	5.8 ± 4.4	4.4 ± 2.1	0.2709
Prolonged Air Leak	8	4	0.3493
VATS	3	3	0.9495

VATS, video assisted thoracic surgery.

and failure of lung re-expansion, two had incomplete medical records, and one patient was non-compliant and intentionally removed the catheter. In two patients, although a percutaneous catheter was initially planned, the procedure could not be successfully completed due to technical failure in advancing the catheter. As a result, these patients were managed with standard chest tube thoracostomy and included in the 28F group for outcome analysis. Ultimately, 78 patients were included in the final analysis: 40 in the 10F catheter group and 38 in the 28F chest tube group (Figure 3). There were no statistically significant differences between the two groups in terms of mean age (10F: 43.9 ± 22.7 years vs. 28F: 36.0 ± 17.4 years; $p = 0.1596$) or sex distribution (male: 75.0% in 10F vs. 89.5% in 28F; $p = 0.1406$). The side of pneumothorax (right-sided: 60.0% in 10F vs. 68.4% in 28F) did not significantly differ between groups ($p = 0.4383$), nor did the presence of COPD (10.0% vs. 10.5%; $p = 0.9382$) (Table 1). The etiology of pneumothorax showed a significant difference between the two groups ($p = 0.0051$). The 10F group included more patients with primary spontaneous pneumothorax (PSP) (65.0% vs. 47.4%) and blunt trauma (22.5% vs. 15.8%), while penetrating trauma was observed exclusively in the 28F group (0% vs. 21.1%) (Table 1).

The mean hospital stay was 7.4 ± 6.7 days in the 10F group and 4.6 ± 2.3 days in the 28F group ($p = 0.0656$). The mean drainage duration was 5.8 ± 4.4 days in the 10F group and 4.4 ± 2.1 days in the 28F group ($p = 0.2709$). Although both durations were longer in the 10F group, these differences were not statistically significant (Table 2).

In terms of outcomes, prolonged air leak (defined as >7 days) was observed in 8 patients (20.0%) in the 10F group and 4 patients (10.5%) in the 28F group ($p = 0.3493$). The number of patients requiring video-assisted thoracoscopic surgery (VATS) was equal in both groups ($n=3$, $p = 0.9495$) (Table 2).

No additional complications were observed in the 10F percutaneous catheter group other than prolonged air leak. However, in two patients, the procedure was unsuccessful due to technical difficulties in advancing the catheter, and these patients were subsequently treated with standard chest tube thoracostomy. Additionally, one patient with tension pneumothorax was managed successfully with a 10F percutaneous catheter without the need for further intervention. Overall, the two groups exhibited comparable clinical outcomes across all measured parameters. The use of a 10F percutaneous catheter appears to be a safe and effective alternative to large-bore chest tubes, particularly in spontaneous pneumothorax and blunt traumatic cases.

Discussion

This study compared the clinical outcomes of 10F percutaneous catheters and 28F chest tubes in the treatment of pneumothorax. The findings demonstrated that, despite being less invasive, the 10F catheter achieved clinical outcomes comparable to those of the traditional large-bore chest tube, particularly in cases of spontaneous pneumothorax and blunt trauma. These results are consistent with previous studies suggesting that small-bore drainage systems can be a safe and effective alternative in selected patient populations [17,18].

The use of small-bore catheters has gained traction due to advantages such as reduced pain, shorter procedure times, and fewer complications related to insertion trauma [19,20]. In our study, although hospital stay and drainage duration were slightly longer in the 10F group, the differences were not statistically significant. This aligns with findings from previous trials that showed no major difference in clinical outcomes between small- and large-bore drainage devices in terms of air leak resolution and hospital course.

Etiologically, our study observed a significant difference between groups, primarily because penetrating trauma was exclusively managed with large-bore chest tubes. This reflects standard clinical practice, as penetrating injuries carry a higher risk of massive air leak or hemothorax, which may not be adequately managed with smaller devices [21]. However, in cases of primary spontaneous pneumothorax (PSP) and blunt trauma, the 10F catheter performed safely and effectively, consistent with reports recommending its use in stable, non-traumatic or closed trauma scenarios [22].

The rate of prolonged air leak was similar in both groups. Although small-bore catheters are sometimes associated with higher recurrence or leak persistence, our findings suggest no clinically meaningful disadvantage in this regard, especially when patient selection is appropriate. The equal need for VATS in both groups further supports the non-inferiority of percutaneous catheter use in uncomplicated cases.

Another strength of our study is that all interventions were performed by a single thoracic surgeon, ensuring procedural consistency. Additionally, thoracic CT and ultrasound guidance were used systematically for diagnosis and catheter placement, enhancing safety and standardization.

Our results support growing evidence that challenges the dogma favoring large-bore chest tubes in all pneumothorax cases. Although randomized controlled trials are limited, numerous retrospective and prospective cohort studies report comparable efficacy between small- and large-bore devices when used under appropriate clinical indications [23].

In our study, no additional complications were observed in patients treated with the percutaneous catheter apart from prolonged air leak. However, in two cases, the procedure was unsuccessful due to technical difficulties in advancing the catheter, necessitating conversion to standard chest tube drainage. This highlights that percutaneous techniques may not always be feasible, emphasizing the importance of anatomical suitability and operator experience in patient selection.

The slightly longer hospital stay and drainage duration observed in the 10F group may be attributed to two main factors. First, because air leaks could not be visually monitored through the 10F catheter, a more conservative discharge approach was adopted in some cases. Second, due to the percutaneous nature of catheter insertion, we preferred this method in patients with more than 2 cm of lung separation from the lateral chest wall to ensure safe placement. Consequently, patients with relatively larger pneumothoraces were more frequently included in the 10F group. These factors may have contributed to the observed differences, although they did not reach statistical significance, as confirmed by the study's power analysis.

In our setting, the cost of a 28F chest tube with a closed

underwater drainage system is approximately 2 USD, compared to 9 USD for a 10F pleural catheter set. While the catheter is more expensive upfront, it may offer advantages in patient comfort and ease of use. However, the inability to visually monitor air leaks led to a more cautious discharge approach in some cases, potentially increasing hospital stay and related costs. These factors highlight the importance of future studies evaluating the overall cost-effectiveness and patient-centered outcomes of small-bore catheter use.

Finally, a number of recent analyses report outcomes similar to ours. For example, Chang et al. [13] observed comparable rates of lung re-expansion, complications, and hospital stay between small-bore pigtail catheters and large-bore chest tubes in various pneumothorax settings. In addition, Lyons et al. [21] found in a multicenter cohort of traumatic pneumothorax cases that 8–10F catheters and 24–28F tubes demonstrated similar efficacy and conversion rates. These reports suggest that, under appropriate patient selection, small-bore catheters may offer outcomes broadly equivalent to those of traditional chest tubes and support their consideration as a less invasive alternative in suitable patients.

Conclusion

In conclusion, the 10F percutaneous catheter represents a safe and effective alternative to the conventional 28F chest tube in the treatment of pneumothorax, particularly in patients with spontaneous pneumothorax and blunt trauma. Its less invasive approach, combined with comparable clinical outcomes, supports its wider use in carefully selected cases.

Limitation

This study has limitations. First, its retrospective nature may introduce selection bias. Second, the sample size, although adequately powered, was modest. Third, long-term recurrence was not evaluated. Future prospective, multicenter studies with larger populations and long-term follow-up are needed to confirm these findings and better delineate the optimal indications for percutaneous catheter use in pneumothorax.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and Human Rights Statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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